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NOTES ON THE BEHAVIOR OF *SPEYERIA IDALIA* (DRURY) (NYMPHALIDAE) LARVAE WITH IMPLICATIONS THAT THEY ARE DIURNAL FORAGERS.

Additional key words: *Speyeria idalia*, diurnal feeding behavior, tallgrass prairie, Kansas.

Populations of the regal fritillary, *Speyeria idalia* (Drury), are in decline throughout its range (Hammond & McCorkle 1983, Debinski & Kelly 1998). This decline has heightened interest in the study of the life history of this butterfly species, especially the juvenile stages. Understanding the larval behavior of *S. idalia* is an important step in understanding the butterfly's overall life history and ultimately, implementing management plans to protect it along with the remaining tracts of native tallgrass prairie. Scudder (1889) was the first to note our lack of knowledge of the natural history of *S. idalia* larvae. Much of what is known, such as the daily feeding patterns, is anecdotal and has not yet been corroborated by laboratory experiments. Larvae of the genus *Speyeria* have been reported to feed on violet plants (*Viola* spp.) at night and remain hidden during the day, away from their host plants (Holland 1931, Ehrlich & Ehrlich 1961, Royer 1988). In Kansas, *S. idalia* feeds primarily on two species of violet: *V. pedatifida* G. Don (the prairie violet) and, to a lesser extent, *V. pratincola* Greene (the blue prairie violet). If the larval strategy is to leave their host plant during the day, the larvae must either relocate the host plant upon which they last fed or find a new one. We studied larval *S. idalia* both in the field and in the laboratory to determine their daily activity patterns.

We first attempted to rear the larvae according to the procedure of Mattoon et al. (1971), but survivorship was very low. Therefore, it was necessary to collect larvae in the field. Field studies were conducted in a native tallgrass prairie (dominated by little bluestem, *Schizachyrium scoparius* Michx.; Indian grass, *Sorghastrum nutans* (L.) Nash; and big bluestem, *Andropogon gerardii* (Vitman) 8.0 km west of the town of Wamego, in Pottawatomie Co., Kansas (T10S, R9E, Sec. 1)). For a more through description of the study site, see Kopper (1997). Searching violet plants at night proved useless. We spent most of our time searching for larvae on and around violet plants during the day in mid-April and early May. Even in the day larvae were exceedingly difficult to find, resulting in the small number (n = 12) used in this study. Where the larvae were found and the behavior that they exhibited prior to collection was recorded (Table 1).

Of the 12 field-collected larvae available, three were parasitized by Hymenoptera and three died from unknown causes, leaving us with six larvae to use for bioassays. We released one 4th instar larva back to the prairie and observed it continuously for 24 hours beginning at 0900 CST. Additional studies were conducted in the greenhouse. Larvae (n = 5) were released into a prairie plot located in the Kansas State University greenhouses. This plot consisted of a portion of native tallgrass prairie (slated for road development) that was dug out to a depth of 40 cm and transplanted into an open-top plywood box (1.83 × 1.22 m). The temperature within the greenhouse was maintained as close to field conditions as possible (28°C during the day, 18°C during the night; 60% RH). The plot was watered once a week. Natural light was used for illumination, so the photoperiod also mirrored field conditions. The larvae were observed every other hour over staggered eight-hour blocks of time to continuously monitor the larvae for 1 week.

We also obtained three larvae from eggs that we reared in the lab and used to film larval behavior. A sand-filled arena (24 cm diameter desiccation chamber) was used for the assay; violet leaves were placed into water vessels, which were buried in the sand. The density of violet leaves in the arena was similar to densities observed in the field. The bioassay was kept at ~20°C and 60% RH. A continuously operating, red low intensity (25 w.) incandescent light source permitted us to film and observe larval behaviors during the scotophase (dark period). The ratio of photoperiod:scotophase that the larvae would experience in the field was maintained in the laboratory, but the phases were reversed. Larvae were held for 1 week under these conditions to allow them to entrain to the new light regimen prior to the bioassay. The larvae were filmed and observed bihourly over various times of the day for 1 week.

We found that, in the field, the larvae were considerably more active during the day and inactive throughout most of the night. When inactive, the early instar (1st–early 3rd) larvae could be found in the curls of the young violet leaves, whereas the later instar (late 3rd–6th) larvae were found at the base of the violet plant. These results may be biased, because we spent a great deal of time searching for larvae in violet clumps. During the day (1000–1600 hours), larvae were feeding, walking, or inactive. When not at the base of violet plants, larvae were found feeding on violet plants (both leaves and flowers) and walking in curved directional paths.

We calculated the probability that larvae would move from one behavior to another by observing larvae (laboratory larvae were observed bi-hourly for one week and the field larva was observed over a 24-hour period) and assessing the change in larval behavior. Larval behavior was characterized into three categories: moving, inactive, and feeding. The change in larval behavior was pooled separately for larvae in both laboratory and field observations. Because of the low sample size (n = 3 for the laboratory assay and n = 1 for the field assay) used for these observations, these results should be interpreted with caution. Also, any differences between laboratory and field data may be due to the nature of the laboratory bioassay, such as a greater likelihood of running into leaves in the arena than finding a plant in the field. Furthermore, temperature or time of day was regrettably not recorded and which may have also influenced larval behavior. Following a period of inactivity, the larvae often started to move as opposed to feeding (52.4% and 75.0% laboratory and field, respec-

TABLE 1. Behavior of larvae found in the wild. All larvae were collected during daylight hours. Time, when recorded, is expressed in military time. nr = not recorded.

Individual	Date	Time	Instar	Behavior when found
1	4/16/97	nr	4th	Inactive at the base of *V. pratincola*.
2	4/22/97	nr	3rd	Inactive at the base of *V. pedatifida*.
3	4/23/97	10:00–10:30 h	3rd	Inactive at the base of *V. pedatifida*.
4	4/23/97	10:00–10:30 h	4th	Inactive at the base of *V. pedatifida*.
5	4/24/97	10:00–11:00 h	3rd	Inactive at the base of *V. pedatifida*.
6	4/28/97	11:00–12:00 h	3rd	Feeding on *V. pedatifida* leaves.
7	4/28/97	11:00–12:00 h	3rd	Inactive at the base of *V. pedatifida*.
8	5/1/97	nr	3rd	Feeding on *V. pedatifida* flower.
9	5/8/97	10:30–11:30 h	4th	Inactive at the base of *V. pedatifida*.
10	5/9/97	nr	5th	Walking towards *V. pedatifida*.
11	5/9/97	nr	5th	Inactive at the base of *V. pedatifida*.
12	5/9/97	nr	5th	Feeding on *V. pedatifida* leaves.

tively). After moving, the larvae typically became inactive again, only feeding 27.8% in the laboratory and 25.5% in the field. However, in the field, encountering food is not guaranteed, and these percentages do not take into account distance traveled. Once a larva in the field had fed, it would either remain inactive or move with equal probability. However, larvae in the laboratory would remain inactive after feeding 81.3% of the time.

Larvae would eat the violet leaves rapidly during feeding bouts and, when not feeding, larvae would hide in clumps of grass or walk. McCorkle and Hammond (1988) observed similar feeding behavior for *S. zerene hippolyta*. The fifth instar larva that was released back to the prairie walked in a curved path (25.40 m over a 24 hour period) and fed only on violet plants that were in its path (although it walked past violet plants as close as a centimeter away and apparently did not perceive them). Wind direction did not seem to matter as the larvae walked equally close to violets up and down wind without noticing them. As the sun set, the larva walked and fed progressively less, until it became inactive at the base of a grass clump and remained there until the following morning. The larvae studied in the laboratory and greenhouse displayed a similar diurnal feeding pattern. The inactivity associated with nightfall may be due to a reduction in temperature, however temperature does not drop substantially as soon as the sun sets in eastern Kansas, leading us to believe that light is a more important cue for activity than temperature.

This study of a small sample of *S. idalia* larvae in Kansas tallgrass prairie indicates that they do not forage entirely at night. More study is needed covering a larger geographic region in order to determine how widespread this behavior is within *S. idalia* and the genus *Speyeria*.

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BIOLOGY OF *ADELPHA MYTHRA* FEEDING ON ASTERACEAE, A NOVEL PLANT FAMILY FOR THE NEOTROPICAL LIMENITIDINAE (NYMPHALIDAE), AND NEW DATA ON *ADELPHA* "SPECIES-GROUP VII"

Additional key words: *Adelpha syma*, *Adelpha cocala*, life history, Rosaceae, Rubiaceae.

The Neotropical genus *Adelpha* Hübner (Nymphalidae) includes about 85 species (Keith Willmott pers. comm.) spread from western USA to Uruguay, and occurring in a wide variety of habitats and vegetation types (Aiello 1984). Species determination is very difficult in some *Adelpha* groups, and the natural divisions of the genus are not yet fully resolved, although a number of species relationships have been proposed on the basis of the immatures (Aiello 1984). Unfortunately, immatures are known for only 32 species of *Adelpha*, solely 21 of which have some portion of the early stages illustrated. Thus, although a cladistic analysis of the genus is needed, it would be impossible at this time. Because information on additional species is essential to a better understanding of the genus (DeVries 1987; Aiello 1991), it is important that any new data about *Adelpha* immatures be reported (Otero & Aiello 1996).

This paper describes the immature stages of *Adelpha mythra* (Godart 1824) and *A. syma* (Godart 1824), reports their larval host plants, and discusses the position of both species within *Adelpha*, based on their immatures.

Study sites and methods. *Adelpha mythra*, a montane species in southeast Brazil, is one of 16 species of *Adelpha* known in the Santa Genebra Forest Reserve (22°44′S, 47°06′W, altitude 600–630 m), a 250 ha fragment of semideciduous forest in Campinas, São Paulo State, SE Brazil (see additional information on the area in Morellato and Leitão-Filho 1995). In January 1999, a female *A. mythra* was observed there ovipositing on the scandent vine, *Mutisia coccinea* St. Hil. (Asteraceae). The egg did not hatch, so this very unusual "record" was thought to be an oviposition mistake of this female. However, from February to April 1999, *A. mythra* was reared from first to fourth instars collected on the same plant species and also on *Bathysa meridionalis* (Rubiaceae) in several parts of the Serra do Japi (23°11′S, 46°52′W), a mountain range (700–1300 m altitude) covered by semideciduous forest, in Jundiai, São Paulo State, SE Brazil (Brown 1992). Immatures of *Adelpha syma* were also found on *Rubus* (Rosaceae) in the Serra do Japi, and immatures of *A. cocala* were discovered feeding on a Rubiaceae in the Parque Ecológico do Voturuá (46°22′W, 23°57′S, altitude 20–100 m), a 200 ha fragment of lowland subtropical rainforest in the city of São Vicente, coastal São Paulo State, SE Brazil.